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Would You Bolt A Swamp Cooler To Your DX Rooftop Unit? [not exactly….]

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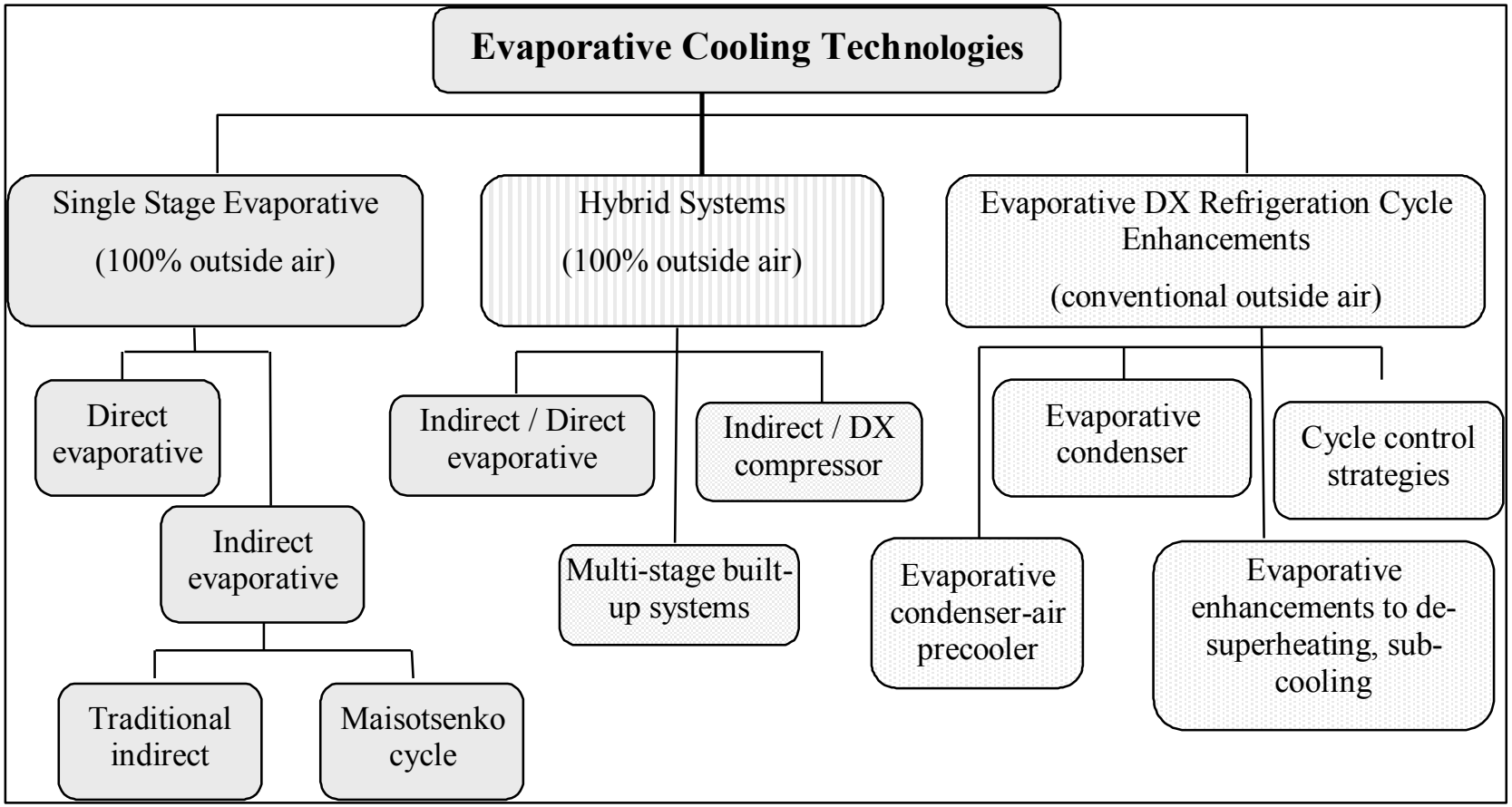
SWEEP-WCEC

July 23, 2013

Evaporative Family Tree



NEEA – NBI Evaporative RTU Projects

- 2007: *CoolAire*, Proof-of-concept, 5-ton Desert Aire Indirect/DX hybrid, multiple sites NW/CA; marketed as the Coolerado *H80*
- 2010: Speakman 5-ton Indirect Direct (IDEC)/ DX hybrid; 2 Idaho sites
- 2012: AirMax, 5-ton IDEC add-on; 1 Idaho site
- 2013: 4th generation AIR$_2$O + Coolerado M50 add ons; 1 Idaho, 1 Vancouver, WA

Desert CoolAire, Portland, OR

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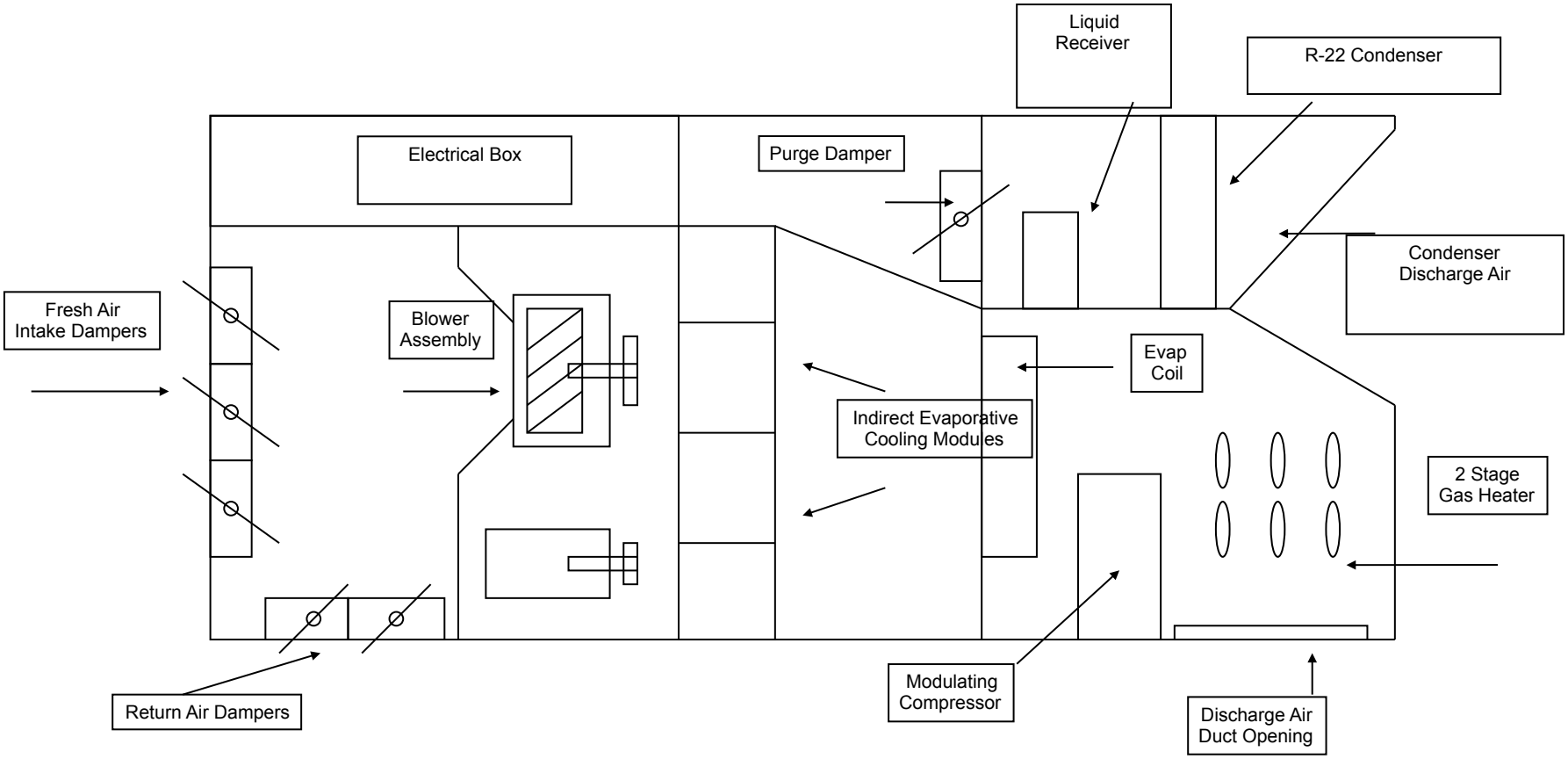
Desert CoolAire™ Package Rooftop Unit

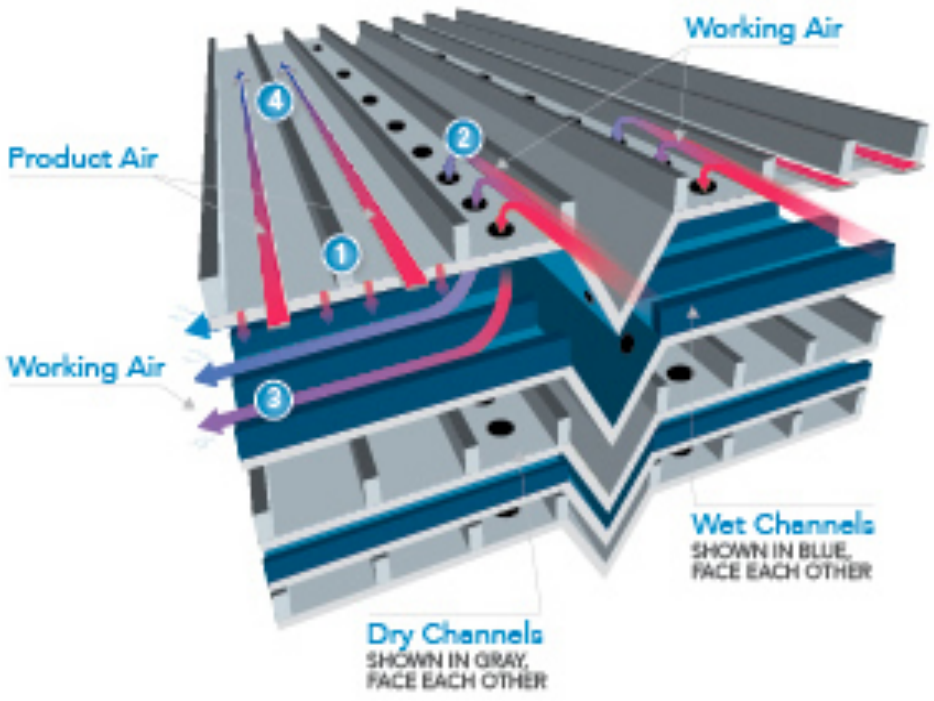
- Refrigerant Capacity (DX): 48,000 btu [1.5t works]
- Total Cooling Capacity: 60,000 btu
- Total Heating Capacity: 115,000 btu
- Compressor: 10-100% Digital modulating scroll
- VFD Blower
- Supply Air: 1800 CFM at 1 inch ESP
- **132”L x 54”W x 60”H**
- **2300 lbs** wetted

CoolAire Unit Layout



Maisotsenko Cycle

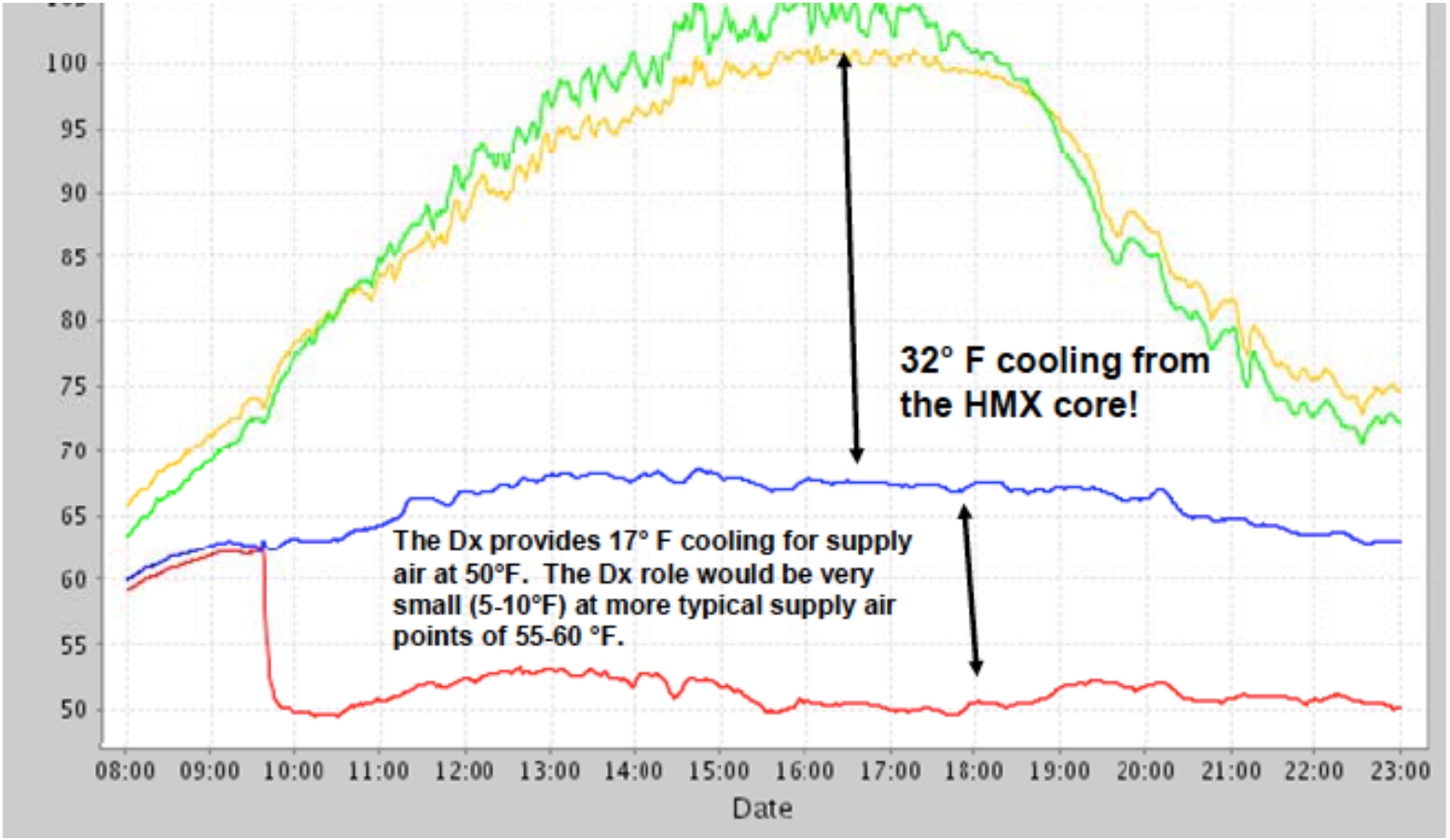
How it works:

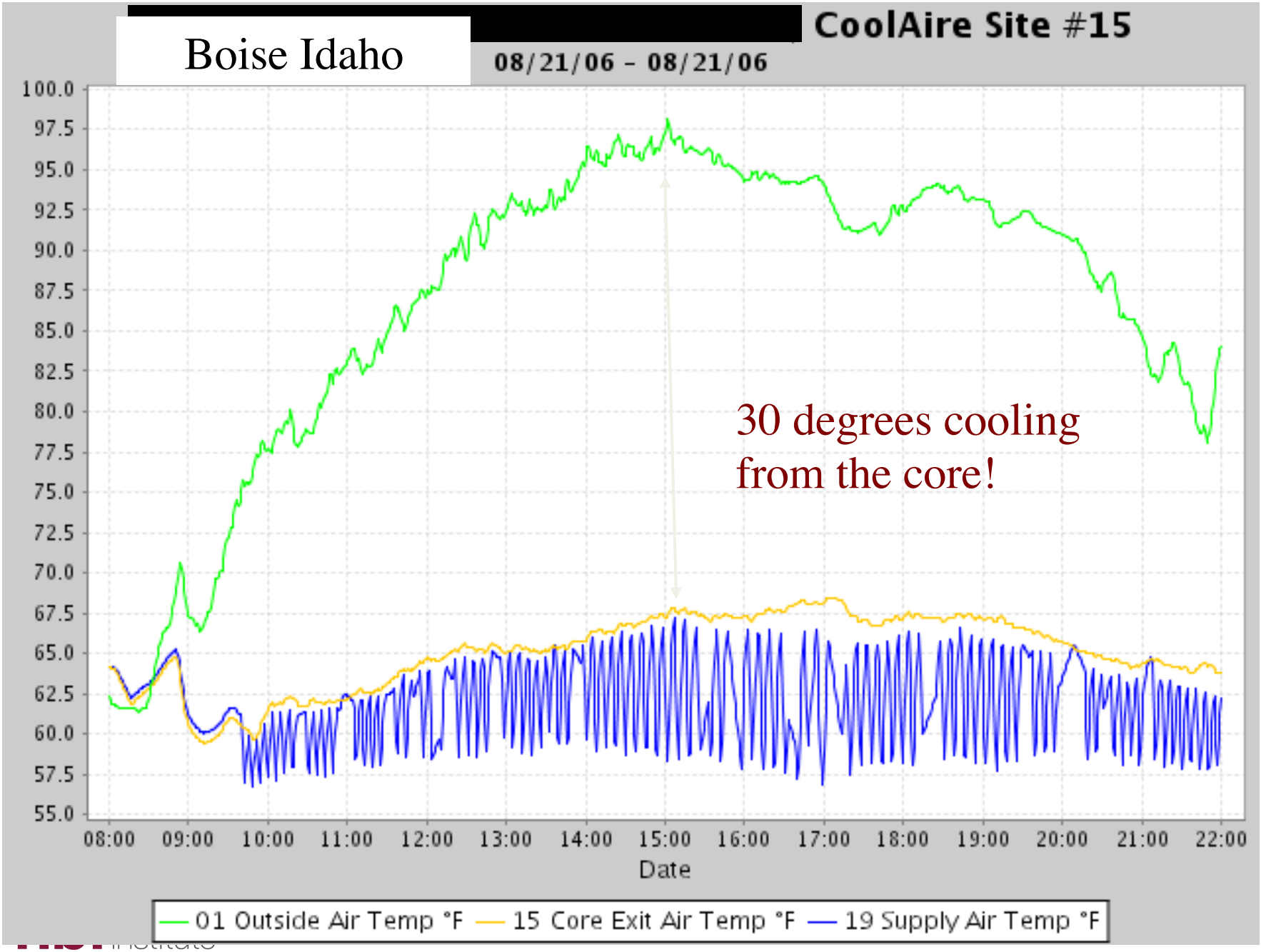


1. Product air and working air enter the dry side of the HMX.
2. Cooled working air is fractioned off into wet channels throughout the exchanger.
3. Heat from the product air is transferred into the working air through evaporation and is rejected as exhaust.
4. The product air travels the length of the dry channels, while transferring its heat to the working air in the wet channels above and below. As a result, the product air cools down and remains dry as it enters the building.

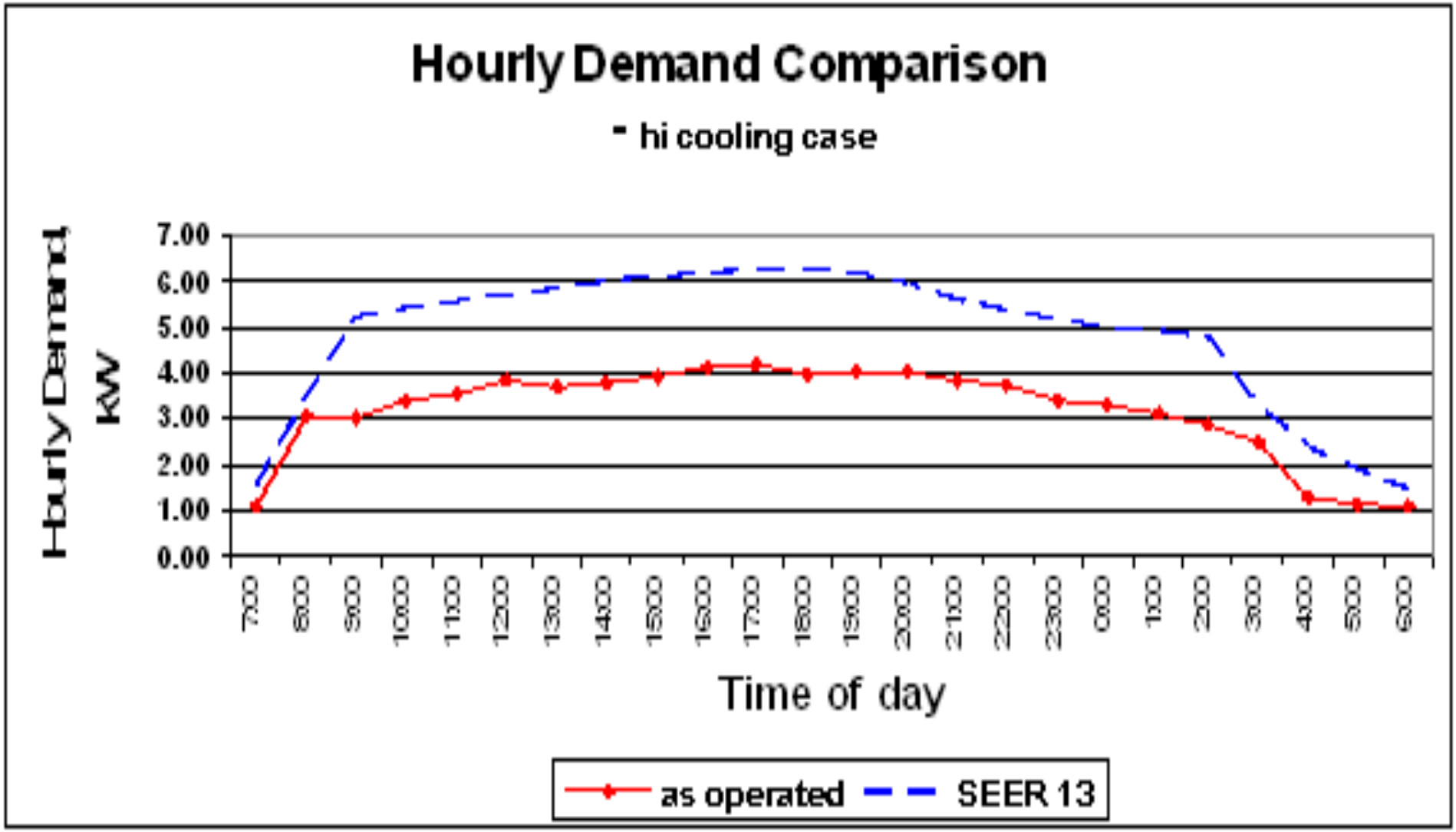
Delphi Indirect HMX Core

CoolAire CA Sacramento 100ºF




Boise Idaho
CoolAire Site #15
08/21/06 - 08/21/06
100.0
97.5
95.0
92.5
90.0
87.5
85.0
82.5
80.0
77.5
75.0
72.5
70.0
67.5
65.0
62.5
60.0
57.5
55.0
08:00
09:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
Date
30 degrees cooling
from the core!
01 Outside Air Temp °F
15 Core Exit Air Temp °F
19 Supply Air Temp °F

CoolAire –Boise 100ºF



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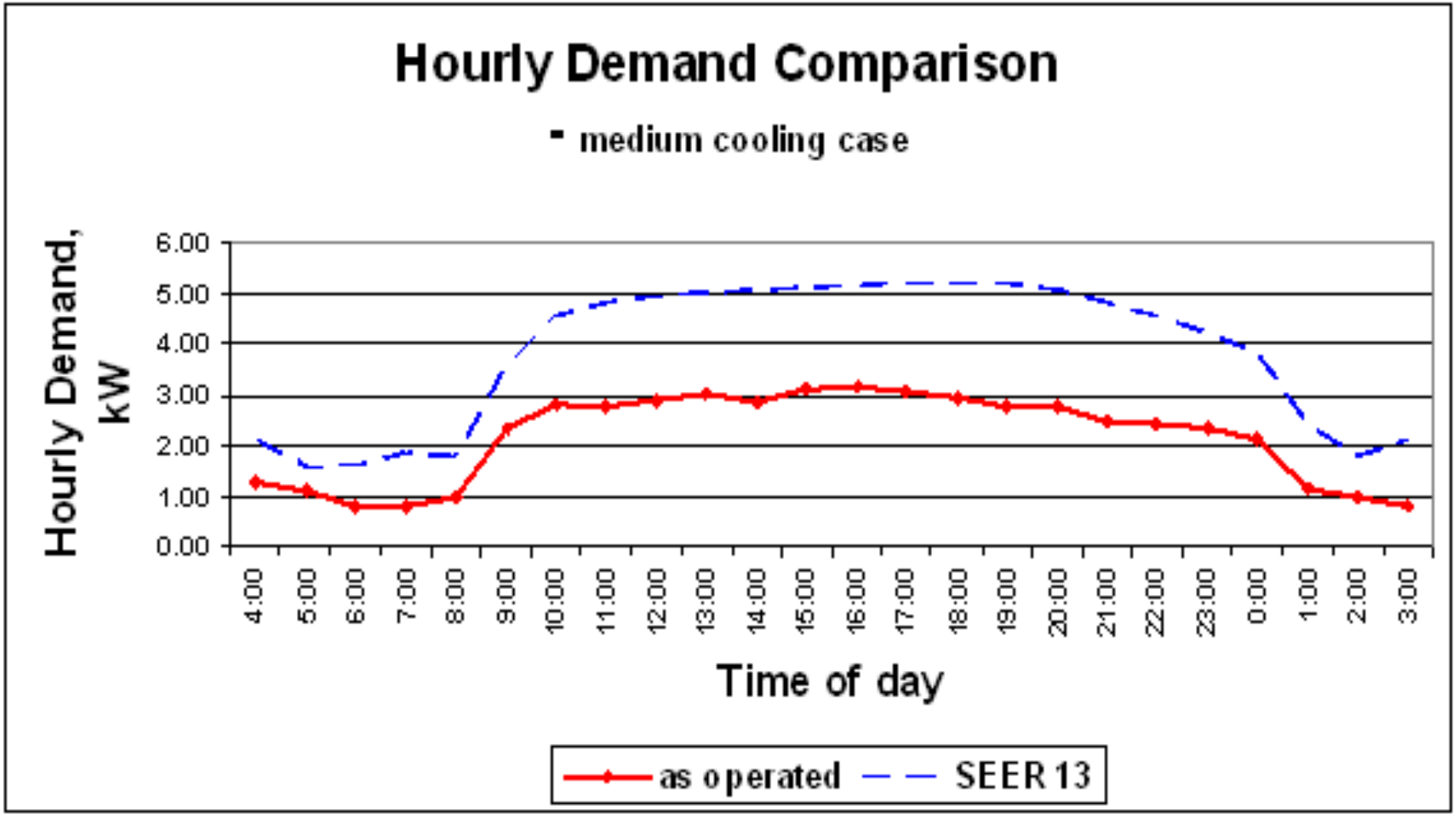
CoolAire Results –Boise 85-87ºF



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CoolAire Findings

- Modest Energy Savings: 23%
- Strong Demand Savings: 2-3 kW (33-49%)
- Non-optimal prototype design & control (excessive fan energy, overuse of Dx, too much H2O)
- 25 EER evap peak/15 EER system @ 103°F
- Possible 20%+ improvement with redesign

Coolerado H80 - Western Cooling Challenge

Coolerado H80, 5-ton RTU, NREL tested

WCC sensible EER spec @ 90°F ≥17 **MEASURED = 51.8 EER**

WCC sensible EER spec @ 105°F ≥14 **MEASURED = 21.7 EER**

MEASURED REDUCTIONS = 80% kWh/58% kW

AIR 2 O™ | QUATTRO™ HYBRID

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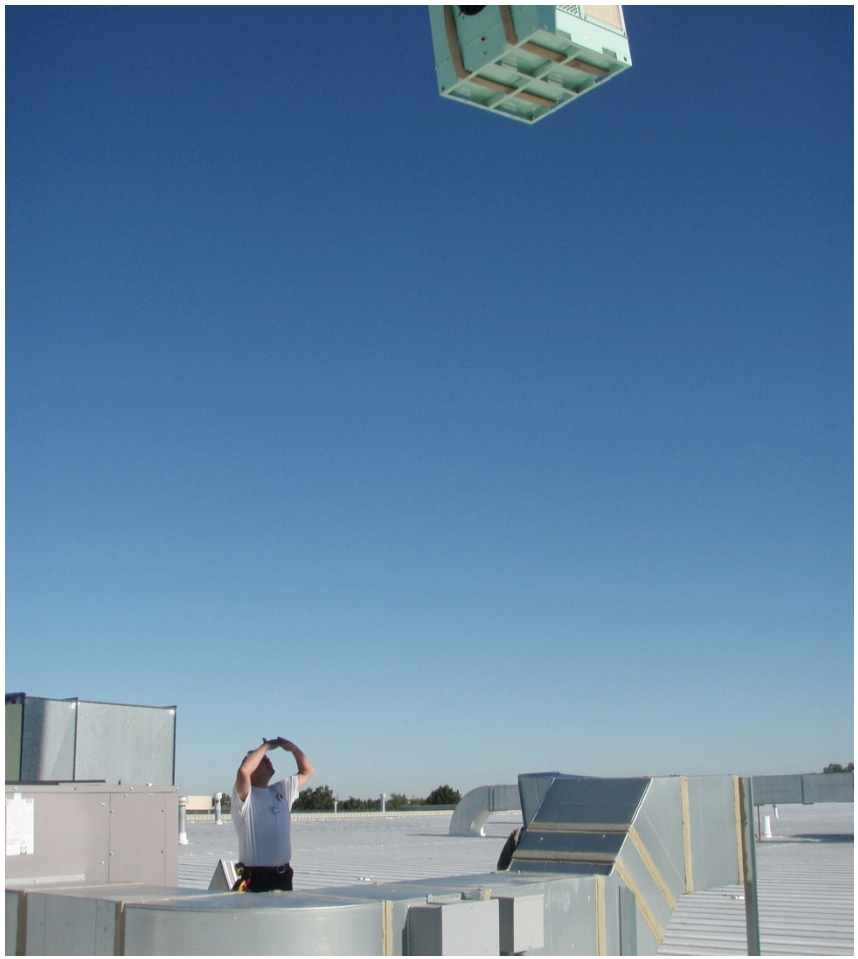
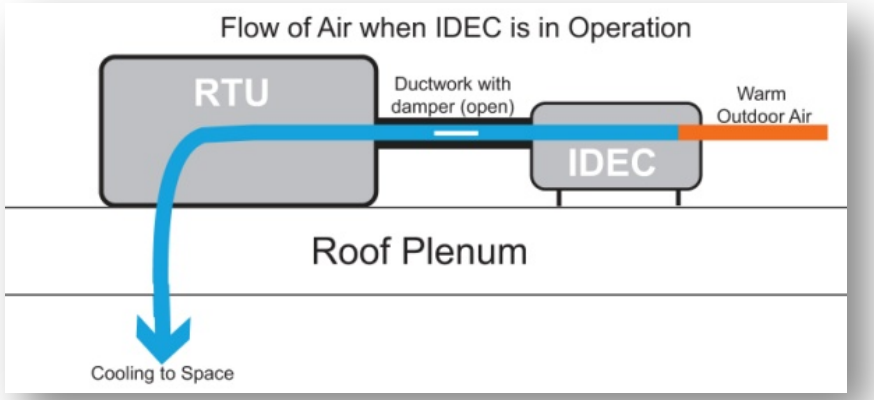
AirMax Indirect Direct Arriving

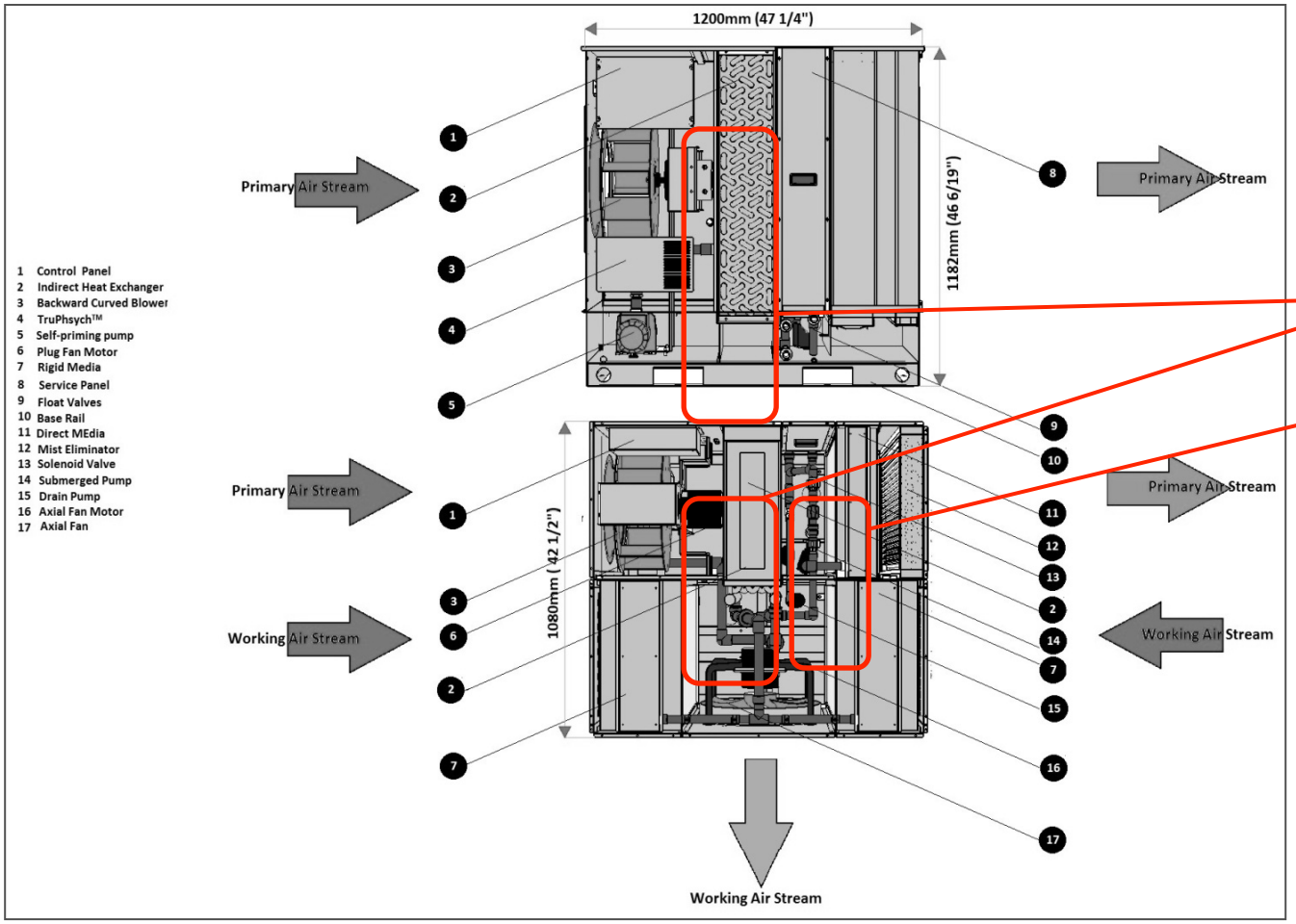


AirMax IDEC
Equipment Overview

- 3 gen unit (2nd gen IDEC/DX hybrid)
- Add-on to existing 5 ton RTU
- IDEC/RTU interface fabricated in the field



AirMax IDEC Overview



Indirect Media

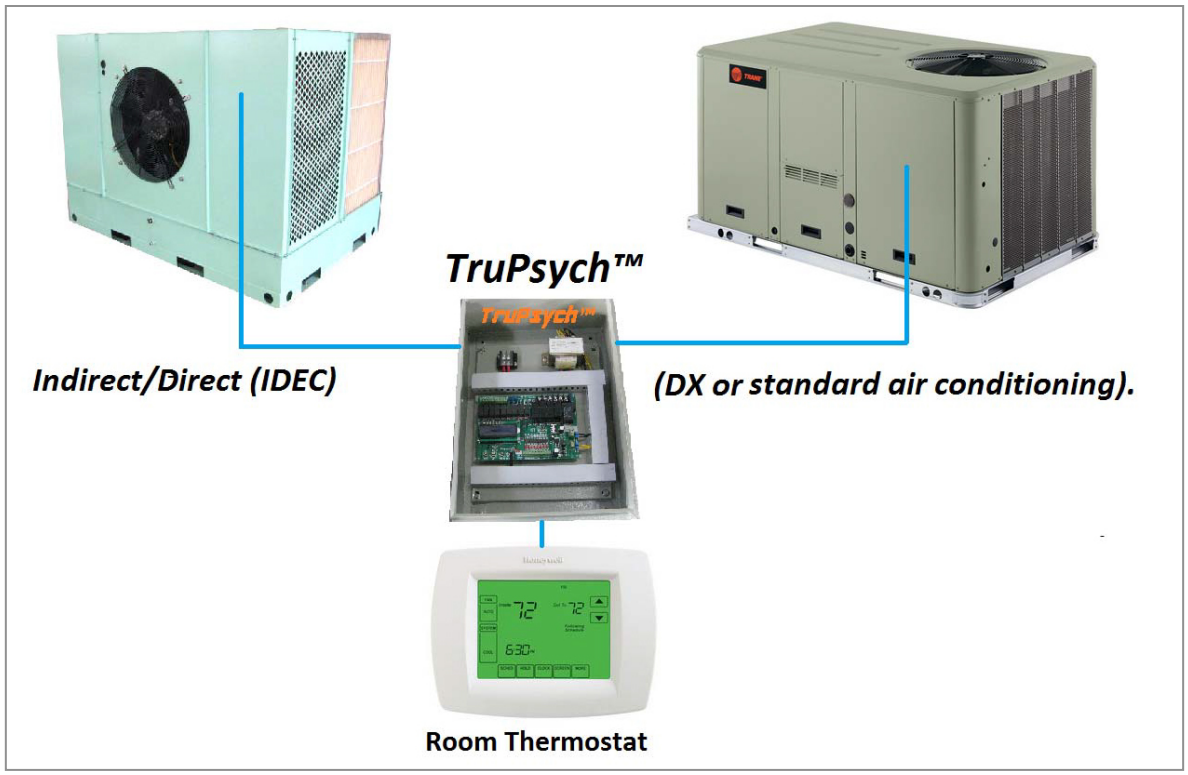
Direct Media

Direct evaporative media Munters CELdek® 5090
Indirect evaporative matrix Munters CELdek®7090

ACSESS™ Controller
(*TruPsych obsolete*)

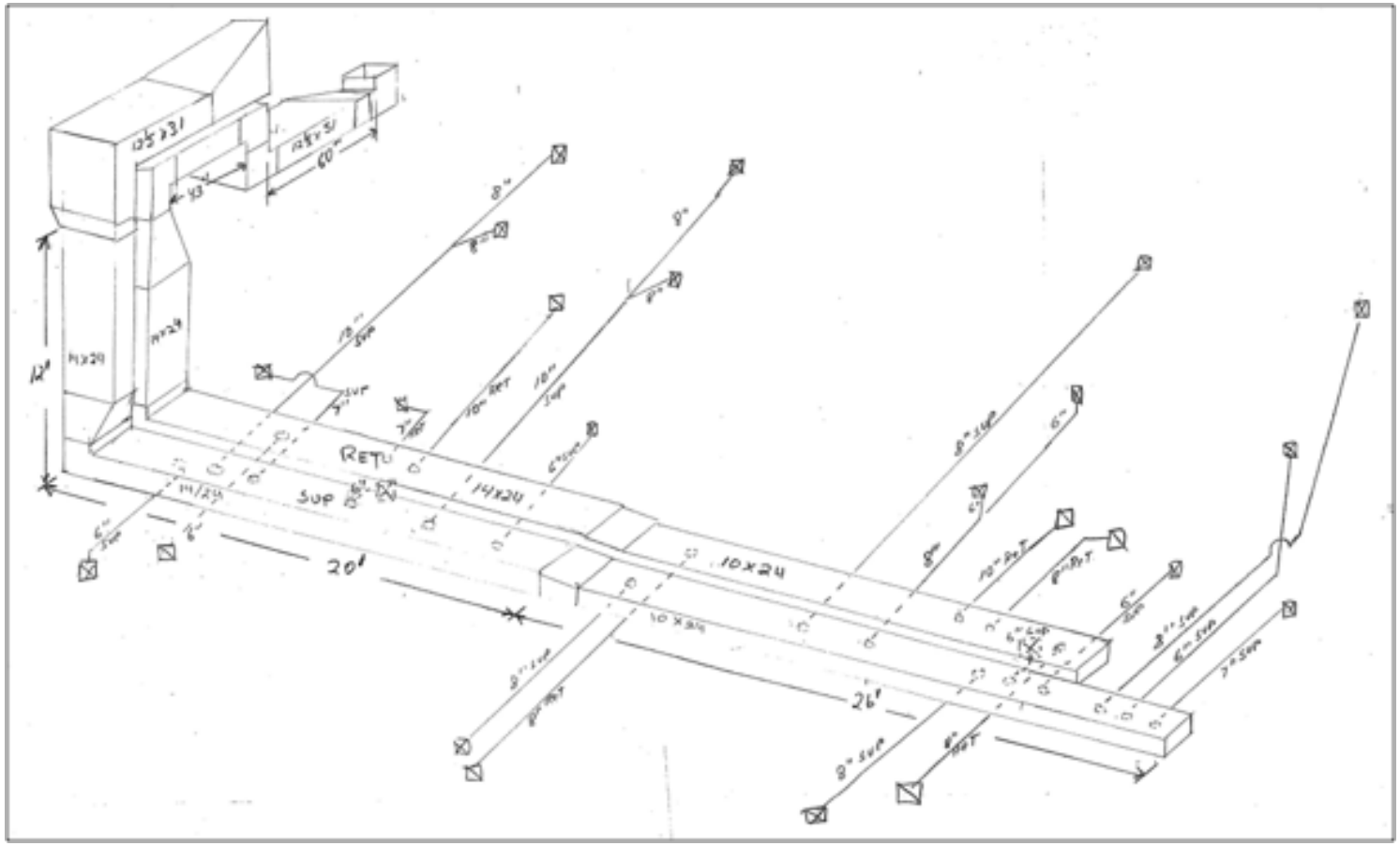
Four modes of operation:

1. Economizer
2. Direct
3. IDEC
4. DX mode

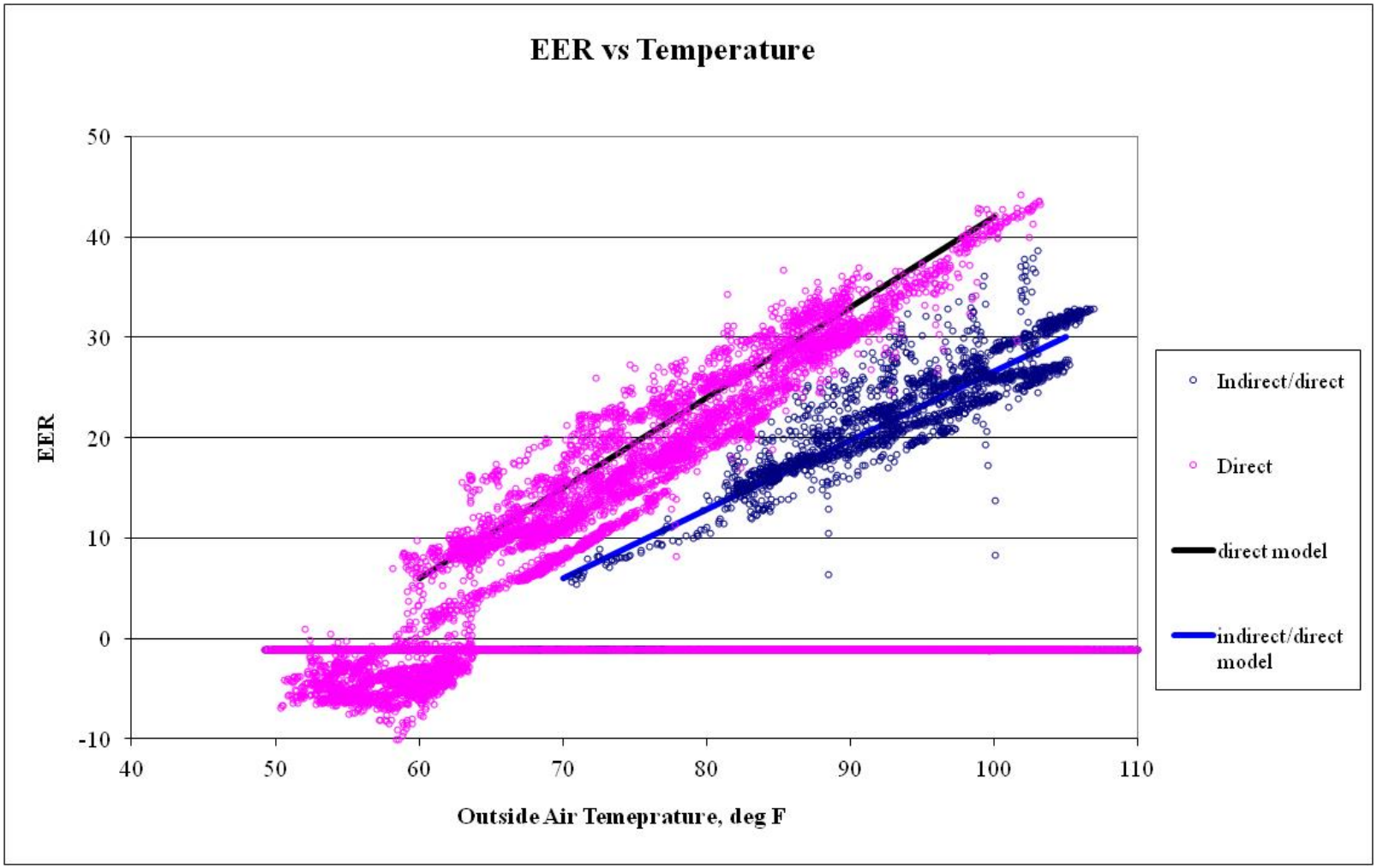


Source: *TruPsych* Technical Guide 2.0

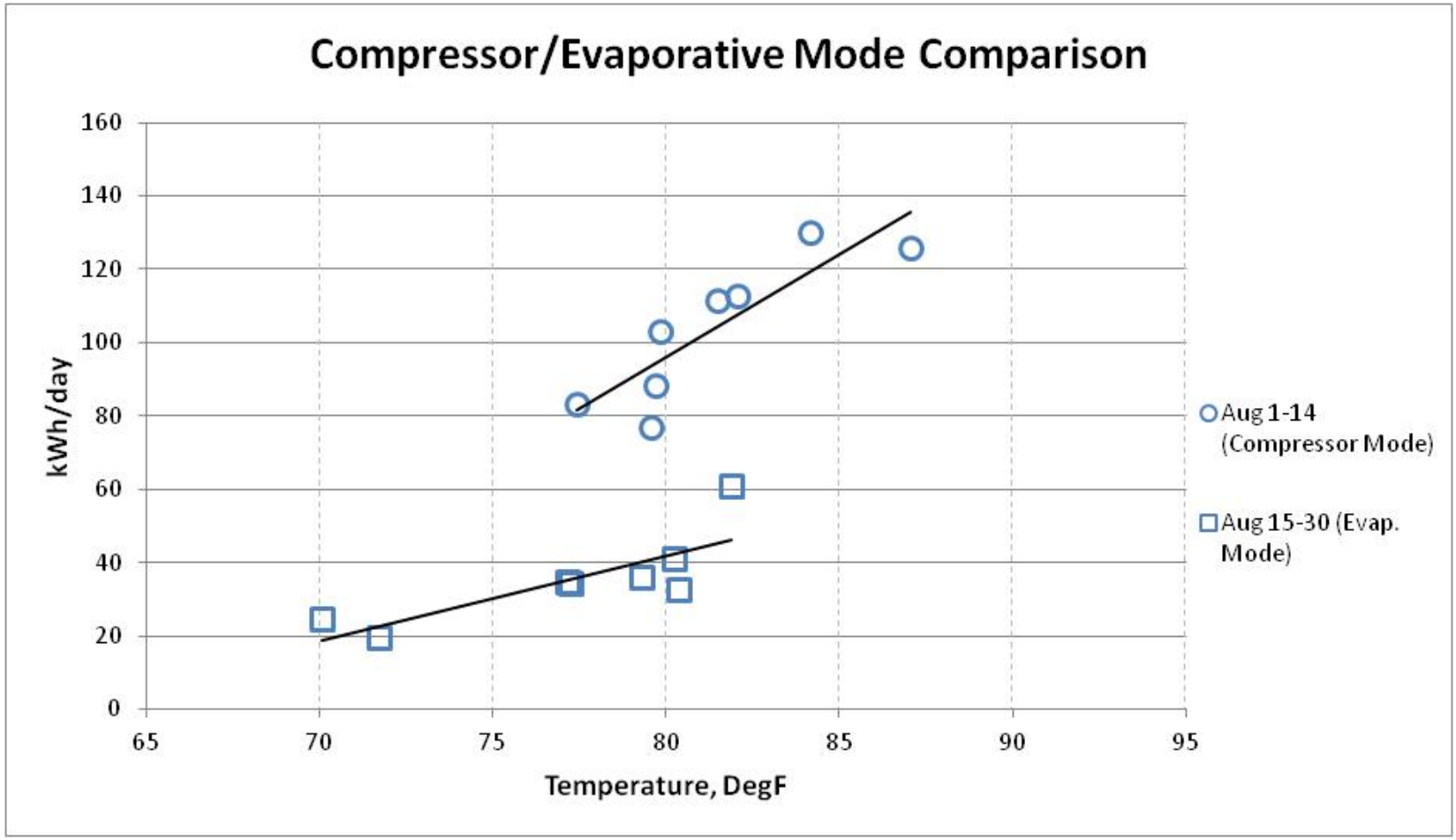
Idaho IDEC Project Ductwork



IDEC Performance

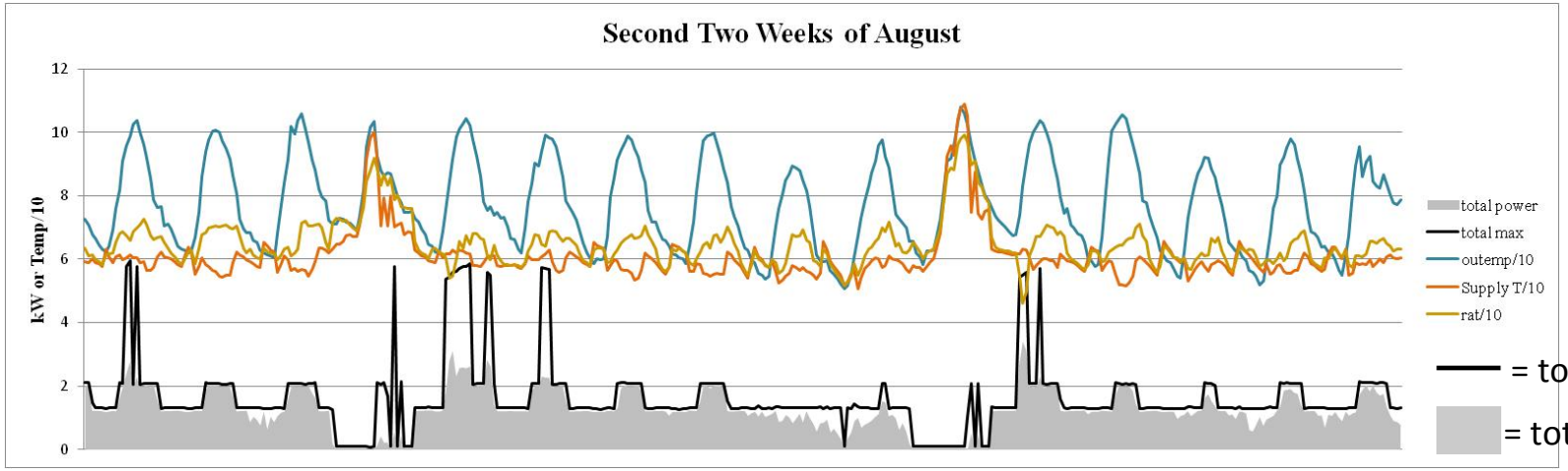


Savings Potential

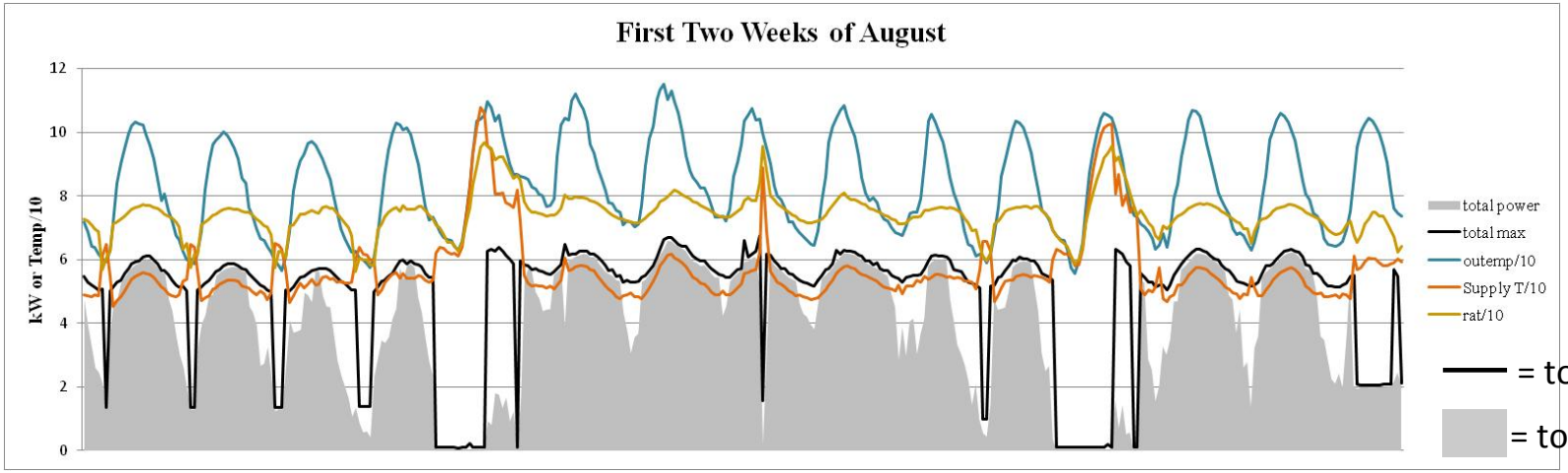


RTU vs. RTU/IDEC

RTU + IDEC cooling



RTU only cooling



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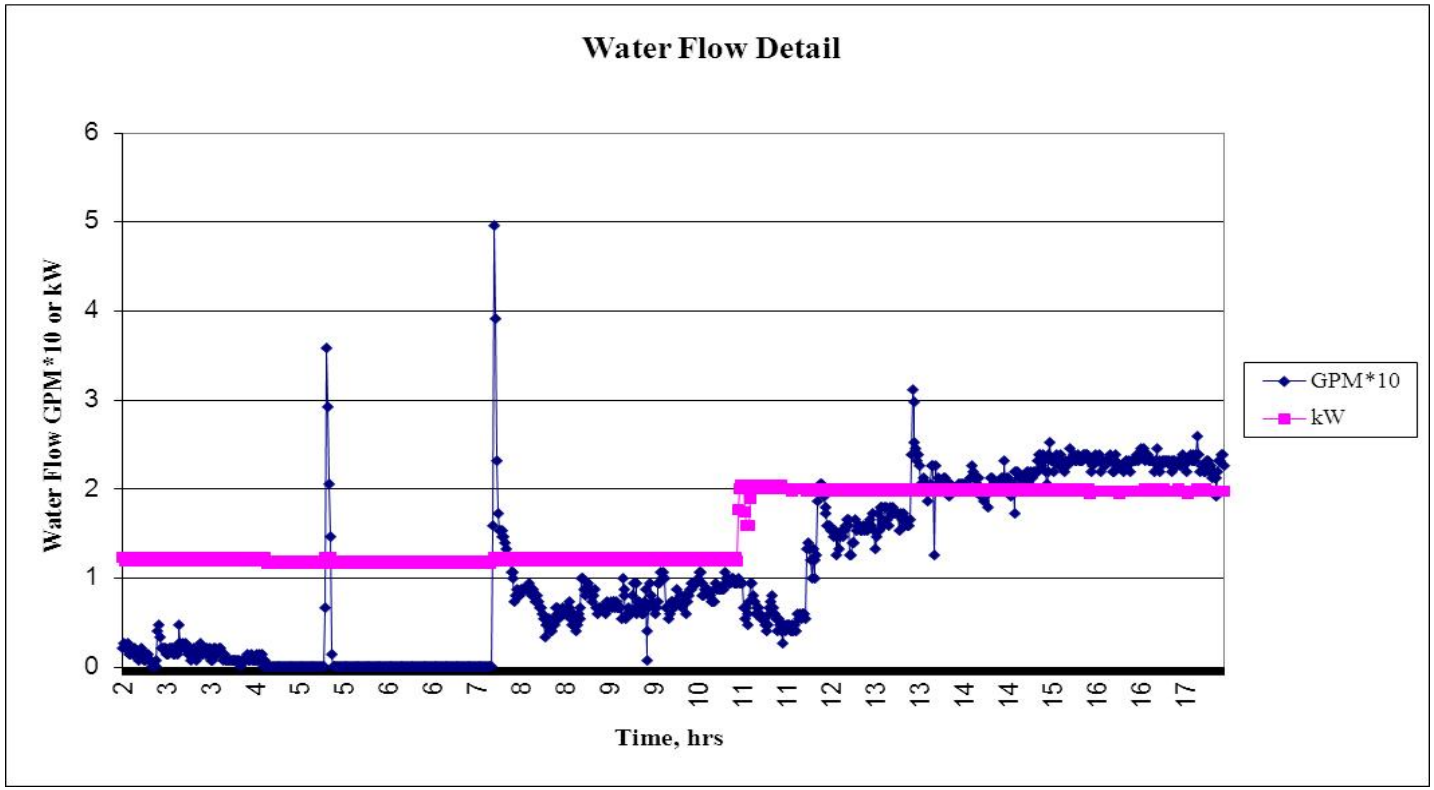
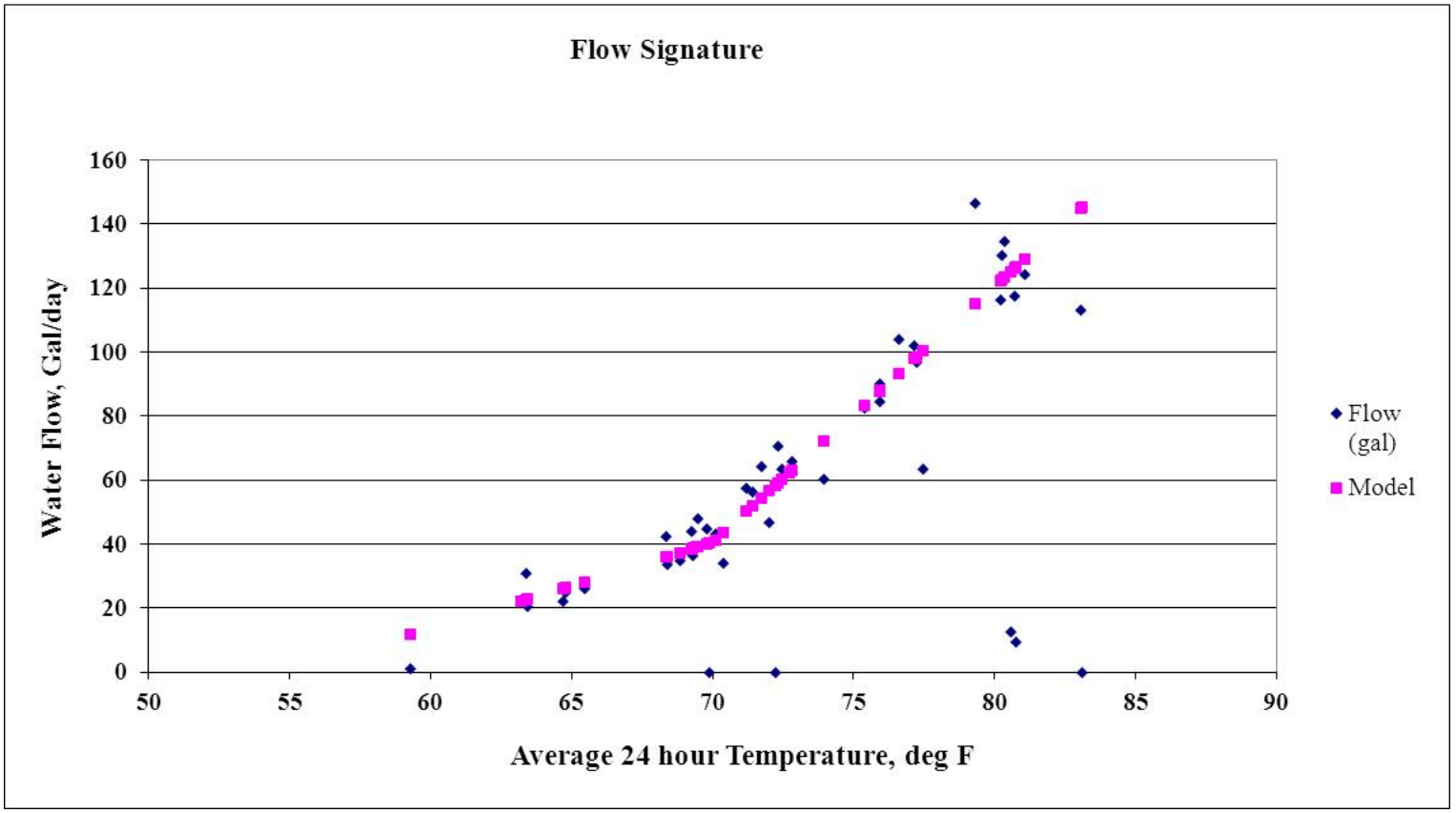
Water Usage



- Direct mode water-use efficiency = 95%
- IDEC mode water – use efficiency = 30%

Water Usage Signature



Water Usage

Table 2. Total Consumptive Use of Water for U.S. Power Plants

Power Provider	Gallons Evaporated per kWh at Thermoelectric Plants	Gallons Evaporated per kWh at Hydroelectric Plants	Weighted Gallons Evaporated per kWh of Site Energy
Western Interconnect	0.38 (1.4 L)	12.4 (47.0 L)	4.42 (16.7 L)
Eastern Interconnect	0.49 (1.9 L)	55.1 (208.5 L)	2.33 (8.8 L)
Texas Interconnect	0.44 (1.7 L)	0.0 (0.0 L)	0.43 (1.6 L)
U.S. Aggregate	0.47 (1.8 L)	18.0 (68.0 L)	2.00 (7.6 L)

Source: NREL 2003

- Water use associated with RTU only energy use = **28,600 gallons**
- Water use associated with RTU/IDEC energy use PLUS direct water use by IDEC = **20,000 gallons**

Summary

Equipment	RTU	IDEC
Electric Energy (kWh)	6,475	2,849
Electric Demand (kW)	5.5	2.2

- Savings projections: energy @ 56%(3,600 kWh/yr) – additional savings achievable with refinement of control settings
- Demand @ 65% (3.6 kW)
- Revisions recommended

IDEC 4th Gen Unit

- Blower change: from external rotor motor 960 W single-speed (2500@ 0.5 inch) to 1.1 kW blower internal rotor 3-speed (3000 CFM @ 0.5 inch or 2500 CFM @ 1 inch)
- Control board changes:
  - Added LCD to replace dipswitches
  - Runs the economizer or direct or direct /indirect as a 3-stages unit which saves water usage
  - Increased purge system control accuracy
  - ACSESS™ control board fully integrated into the cabinet
  - Water coil and water pump redesigned completely to allow 100% winter drain down
  - Standard' beige cabinet color

GreenAire AIR$_2$O

AIR_2O IDEC US Savings Estimates

City	Rank	Total Evap. IDEC +Direct Hrs/Yr	Evaporative Direct Hrs/Yr	Evaporative Indirect/Direct Hrs/Yr	DX AC Hrs/Yr	Total Non-Economizer Cooling Hours	% Without DX AC	IDEC Add-on kWh Savings	kW Peak Demand Yearly Savings	Water Consumption Avarge G/Ton/Hr
Phoenix, AZ	1	4579	2905	1674	1184	5763	79%	51%	59%	1.2
Las Vegas, NV	2	4328	3052	1276	223	4551	95%	62%	65%	1.3
Fresno, CA	3	3530	1970	1560	347	3877	91%	57%	53%	1.1
Albuquerque, NM	4	3007	2493	514	13	3020	100%	67%	64%	1.2
Salt Lake City, UT	5	2497	2119	378	2	2499	100%	55%	48%	0.6
Lubbock, TX	6	2471	1499	972	1295	3766	66%	42%	52%	0.8
Denver, CO	7	2288	2080	208	18	2306	99%	68%	64%	1.1
Boise, ID	8	2041	1773	268	1	2042	100%	68%	73%	1.1
Los Angeles, CA	9	2035	1333	702	727	2762	74%	47%	40%	0.4
Oklahoma City, OK	10	1283	783	500	2397	3680	35%	18%	36%	0.3
Atlanta, GA	11	1274	807	467	2793	4067	31%	16%	28%	0.3
New York City, NY	12	1146	729	420	1725	2871	40%	24%	26%	0.3
Chicago, IL	13	1141	696	445	1201	2342	49%	31%	33%	0.4
Charlotte, NC	14	1061	785	276	2768	3829	28%	15%	23%	0.2
Austin, TX	15	1046	653	393	4252	5298	20%	14%	20%	0.2
Seattle, WA	16	1029	824	205	5	1034	100%	63%	59%	0.7
Boston, MA	17	1016	667	349	1166	2182	47%	29%	31%	0.4
Indianapolis, IN	18	995	692	303	1824	2819	35%	18%	34%	0.3
Madison, WI	19	971	632	339	1005	1976	49%	25%	30%	0.3
San Francisco, CA	20	969	858	111	16	985	98%	66%	52%	0.6
San Antonio, TX	21	959	675	284	4621	5580	17%	12%	23%	0.2
Washington, DC	22	927	601	326	2099	3026	31%	19%	33%	0.3
Kansas City, KS	23	783	543	243	2514	3297	24%	11%	28%	0.2
Omaha, NE	24	708	456	252	2216	2924	24%	12%	31%	0.2

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Evaporative Cooling Challenges

- Old direct evaporative technology image
- Managing mineral scale
- Putting water usage in context
- Potential changes to ventilation design for higher airflow rates
- Lack of recognition in codes and HVAC efficiency ratings
- Lack of knowledge on the part of owners, contractors, designers, facility managers
- Advanced evap. vendors are small companies
- Limited regulatory, policy & utility involvement

Thanks To All

- http://newbuildings.org/sites/default/files/DesertCoolAireTechAssessFinalReport_July07_0.pdf
- http://newbuildings.org/sites/default/files/NEEA-DesertCoolAireTechnicalAssessment2007Addendum_0.pdf
- http://newbuildings.org/sites/default/files/NBI_NEEA_40363_EvapHVACreport.pdf

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